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ABSTRACT

This research study analyzed an electronic conversation that occurred on the LabNet network, an electronic network for science teachers. A conversation about the nature of science that occurred for eight weeks among ten science teachers was analyzed in order to identify the characteristics of messages that start and sustain a conversation and to examine the ideas presented in messages that are ignored. Important issues about telecommunications' potential as an innovative approach for professional development are highlighted. This research suggests that an electronic network such as LabNet can create conditions that enhance teachers' knowleddge of science and foster their colleagueship. Participating on electronic networks with colleagues in distant towns, however, has the potential to contribute to the isolation many teachers already feel in their own schools. Identifying the factors that precipitate and support reflective conversations on electronic networks may encourage teacher dialogue and collaboration in both proximate and distant communities. Contains 21 references. (Author/JRH)

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Talking about Science: The Case of an Electronic Conversation

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Abstract

Can telecommunications create new paths for professional development? Are networks vehicles for in-depth conversations about science? In this paper the authors describe a research study in which they analyzed an electronic conversation that occurred on the LabNet network, an electronic network for science teachers. The authors describe a conversation about the nature of science that occurred for eight weeks among 10 science teachers on the network. Through a case study of the conversation they identify the characteristics of messages that start and sustain a conversation and examine the ideas presented in messages that are ignored.

The authors raise important issues about telecommunications' potential as an innovative approach for professional development. Their research suggests that an electronic network such as LabNet can create conditions that enhance teachers' knowledge of science and foster their colleagueship. Participating on electronic networks with colleagues in distant towns and cities, however, has the potential to contribute to the isolation many teachers already experience in their own schools. Identifying the factors that precipitate and support reflective conversations on electronic networks may encourage teacher dialogue and collaboration that is both proximate and distant communities.

Introduction

Walking into the teachers' room or department office of any American high school, one typically hears conversations about the day-to-day demands of teaching, Sunday's football game, or anecdotes about classroom life. The social and cultural context of the American high school rarely allows for in-depth conversations about a particular discipline such as

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biology or physics. And, there are few opportunities for teachers to talk about pedagogy in such a way that they reflect on how their practice influences students' learning.

Lacking opportunities for reflective dialogue in the work day setting of the high school might be less of an impediment for teachers' professional development if they had other forums for discourse. Unfortunately, most teachers do not. In fact, staff development as practiced in the United States is typically considered and conducted as training - training to use a specific curriculum or method of teaching *(Fullan, 1991; Little, 1993)*. Such training is usually short-term-a week in the summer or a few after school sessions - and there is minimal and often no follow-up to support teachers' efforts with new materials or approaches. Perhaps the most critical failing of the current staff development practices is that teachers have little opportunity to work as colleagues, together considering the pertinent issues about teaching and learning.

Changes in professional development are necessary. The prevalence of science and technology in the world and workplace demands that students have a scientific literacy that surpasses the science knowledge of previous generations. Thus, the National Research Council (1994) and the American Association for the Advancement of Science (1993), representing United States scientists, educators, and policy-makers, have developed standards for what students should learn and master in the various domains of science. Enacting these reforms requires that teachers deepen their subject-matter knowledge, develop a range of pedagogical approaches - oftentimes new approaches, and assess students in ways that more authentically mirror new curricular approaches. Clearly, these standards will require the creation of and experimentation with new structures of professional development.

New ventures in professional development should give teachers time to work as colleagues, delve into their own projects in science, and experiment with pedagogy. Teacher networks and study groups - both proximate and electronic - have demonstrated their power in supporting teachers' growth and development *(Davis, Taylor, Tearle and Wright, 1992; Lieberman and McLaughlin, 1992; Little, 1993; DiMauro and Gal, 1993)*. Despite time constraints and technical obstacles, teachers in networked communities put forth great effort to participate as networks give them opportunities to work with colleagues, explore teaching dilemmas, have conversations about science or mathematics, and talk about their students' learning *(Lieberman and McLaughlin, 1992; Muscella and DiMauro, 1994; Riel, 1992)*.

Telecommunications has the potential to offer new approaches for teachers' professional development as its purposeful use seems well-suited in fostering meaningful learning for teachers. Using networks to support and publicly share conversations about practice potentially offer teacher-teacher collaboration - important contributors for realizing reforms in science education. The characteristics of electronic networks that appear to offer new vehicles for professional development are:

- support substantive and reflective conversations;
- have a particular focus (i.e. writing, science, school change, reflection on practice);
- create an environment that fosters colleagueship; and
- put teachers at the helm of their own professional development.

There are an increasing number of electronic networks being created for professional discourse; however, there is little known about the uses and impact that computer-mediated communication (CMC) has on teacher professional development *(Bruce & Rubin, 1993; DiMauro & Gal, 1994; Newman & Torz, 1990)*. Thus, we raise the following research question:

> *What types of professional development opportunities support teachers' collaborations that can be offered effectively on a telecommunications network?*

In this paper we present an analysis of an electronic conversation in which high school science teachers explored scientific theories. Traditional teachertalk normally takes place in the teachers' lounge and, by virtue of teachers' hectic schedules, is usually hurried and fragmented. The conversation-case study is a marked departure from such teacher-talk. Teachers explored their beliefs about the nature of scientific inquiry, classroom practices, and their interdisciplinary understandings of scientific notions.

The LabNet Network

During the past five years the LabNet project has designed a telecommunications network with and for K-12 science teachers. LabNet is hosted on a private area of America Online© - a national commercial network service. A variety of experiments have been created to test what features of network-mediated discourse promote a community that supports conversations about science and teaching science *(DiMauro and Gal, 1993)*. The LabNet community is comprised of over 1,200 science and math teachers from the 50 states in the United States, Canada and the islands. At present there are 5,300 messages posted on LabNet as well as 527 folders (representing over 10,000 messages) that have been archived to make room for more folders on the network.

The LabNet network is composed of several distinct areas, each serving a different function. The *library* has articles from periodicals, journals, classroom activities, and archived LabNet conversations that teachers can download. *Topic areas* are designated for physics, biology, and chemistry along with several other interest areas, like collaborative projects. The *community forum* is composed of folders that address both science and non-science issues that teachers face. *Working groups* are used by teachers who work together on particular topics, like curriculum or network leadership. Each area works like

a topic centered bulletin-board service (BBS), yet is available only on the LabNet area.

Case Study: Breaking Barriers in Teacher Talk

The conversation-case study we present is called *Against Method,* located in the *community forum* and found in the folder, Issues in Education. In this folder there is an eclectic collection of such conversations as the physics of car accidents, how students develop science concepts, and what a quality school is. A core group of 15 teachers participates in the ongoing discussions, while about 20 other teachers post message occasionally. Issues in Education was started in September 1993 by Andrew, a physics teacher in a private school in Minneapolis. During the 17 months of its existence 35 teachers have participated in conversations, posting a total of 202 messages in the folder. Each month an average of 15 messages are posted in this folder by about six teachers. Different teachers join in conversations depending in their interest in the topic.

Andrew is both the creator and the moderator of Issues in Education. As the moderator, he poses new questions for discussion about every six weeks. Sometimes the question quickly opens a whole new topic for discussion. This was the case with the first question that Andrew posted. He asked what bureaucratic obstacles others faced in their teaching - what got in the way of their teaching science? After a few responses to his question, the conversation quickly evolved into a discussion about a dream school and what education could become. Many months later, Andrew asked why the American high school was portrayed as a wasteland in the media and popular culture. This, however, was a conversation that never developed. Instead, the teachers continued their prior discussion about time wasters in high school. At other points in the folder, teachers other than Andrew have raised topics for conversation and posed questions and dilemmas.

The conversation, *Against Method,* began with one of Andrew's questions. On 17 April 1995, Andrew posted the 100th message, asking what other teachers thought about the scientific method (*The 100th Message,* Andrew, 94-04-17).

> ....As a science teacher, I find that I observe the world through lenses that tend to demand objective, verifiable truth. This approach has its roots in Greek thought, and really hits its stride with Descartes, Galileo, and Newton. It seems to have permeated our society. The trouble is, it hasn't permeated all societies. There are many other perspectives that would be seen as more holistic, and that allow for an understanding of the part of the human experience that we call the soul. Science must divorce itself from any discussion about the soul, since experience there is not verifiable in any objective sense, nor can one person's experience be effectively communicated to another person. What are the consequences of this failure in the scientific method? What do we communicate to students by ignoring what can not be objectively verified?

From 17 April until 3 June 1994, ten teachers posted 25 messages in which they grappled with the notions of the philosophy and hermeneutics of science. The conversation ended on 13 June when Daniel asked for information about integrating technology and science. To date, no one in the folder has returned to this conversation about the nature of science.

An Analysis of the Network Conversation: AGAINST METHOD

Throughout the network conversation *Against Method* the teachers shared their understanding of the scientific method and its' relationship to both their own learning and teaching. Teachers had diverse opinions and beliefs about the relationship that theory, experimentation, and data played in developing scientific theories. That scientists employed no one particular method in conducting scientific inquiry became evident to the teachers during the discussion. Teachers considered that the "scientific method" is not a static methodology; rather, that scientific inquiries are as individual as the scientists themselves. Teachers discussed Paul Feyerabend's book, *Against Method,* which explores the nature of science and knowing. During the discussion they corroborated or challenged their own notions of scientific practice, drawing from their experiences as teachers and learners.

Any conversation, whether it takes place in the same room or through an electronic network, can be heard from the multiple perspectives of the participants; that is, different people often have different interpretations of the same message. The same is true in analyzing a conversation. The particular analytical perspective depends not only on the research framework but also on the knowledge the researcher brings to the subject's conversation, community, and the network's environment. Using principles of qualitative research, we have analyzed this conversation through several different lenses. These include what science is talked about and how it is discussed, the roles that different messages play in the conversation, references to previous messages, and tracing changes in message titles.

We have analyzed several dimensions of the conversation *Against Method.* Previously we reported on the use of a *personal learning perspective* in which teachers referred to insights about their own understanding of the nature of science *(DiMauro and Muscella, 1994).* In this work we also traced the evolution of a conversation as an index of the concepts developed during the dialogue. There are additional characteristics of this conversation that we believe shed light on the dynamics of a substantive conversation about science. These are the:

- content and tone of the initial messages;
- messages that sustain interest and participation in the discourse;
- ideas that are ignored in the conversation.

The Content and Tone of the Initial Message

What starts a conversation on the network? Is it one message or multiple messages? What is the content of the initial message(s)? In the case of this particular conversation, *Against Method,* there was not one "first message" but four. Andrew's question presented a dilemma about how we verify our knowledge of the physical phenomena that we encounter in the world (see page 8). In the fourth message in this folder, Colleen reflects on Andrew's questions in such a way that Jay and Andrew build on her message, almost as if

the three were co-authoring a paper.

In the section above we presented the partial text of Andrew's message in which he posed a question. There are a few elements of this message that seem to "hook" Colleen and Jay into the conversation in such a way that they begin to shape the conversation. Andrew did not simply ask a question. Instead, he briefly cited the roots of the scientific method and then posed a dilemma. Other cultures "know" the world through ways other than objective reality so what price do we [scientists] pay by allowing only objective reality in theory building and ignoring the soul, which is not verifiable in the objective world. In this message Andrew 1) provides factual information; 2) presents a dilemma; and 3) raises a thought-provoking question.

Colleen responds to Andrew's question about "objective, verifiable truth," considering the differences between "pro forma science" versus "science that advances bold, new frontiers." We found three important aspects of Colleen's message that led Jay and Andrew to give more definition to her reflections. She made *oblique assertions,* cited *personal learning experiences,* and *stated her beliefs* (What science leaves out, Colleen, 94-04-25).

In the beginning of her message, Colleen makes an *oblique assertion,* and shares her skepticism about how we are led to believe scientific inquiry is conducted. She does not claim "regular" science to be sterile. Instead she uses the more tentative, "I sense..."

> When you talk about the scientific method and objective, verifiable truth, I sense a certain sterility. But I donÕt think that the foundations of science as we know it, the theories, were conceived in this barren context....Every bold new advance had its roots in a fertile imagination....

This oblique assertion invites others into the conversation by addressing them directly: "When *you* talk about scientific method.... [authors' italics]. " The conversational tone invites response because it is open-ended. By not making definitive assertions, Colleen creates an inviting framework in her message that resembles thoughtful musings. She uses an analogy to compare method and discovery - method is sterile and barren while fertility and life-fullness is scientific discovery: "Every bold new advance had its roots in a fertile imagination." She melds talk about science with literary devices and language.

Next, Colleen reports a personal learning experience. She describes an "ah-hah" experience as a high school math student when she had her first glimmer of what scientific theory meant to her. She recounts her lack of understanding as a tenth grade geometry student, "I was basically clueless," and then describes when she began to gain some understanding of geometry's purpose.

> ....it reminds me of when I was in 10th grade trying to learn geometry. For six weeks, I did everything I was supposed to do methodically step-by-step....I was basically clueless as to the big picture.... All of a sudden things fell into place...

Colleen opens a window to her own learning, reflecting on how the experiences have shaped her beliefs about learning and theory. This is a critical move for two reasons. First,

by evoking a personal memory, she shapes a forum for others to respond from their experiences. By not posturing as an expert she creates a friendly environment and also provides some information about her feelings and beliefs as a learner. Thus, she takes a step to community-building within the context of this conversation.

Colleen concludes the message, *Against Method,* by *asserting the belief* that the teaching of science is a dichotomy - "a lifeless collection of laws....or a dynamic process," returning to the analogy of method as "barren." She again places herself in the position of the learner, stating that she cannot teach science dynamically until she comes to understand "the dance" of theory and data. The metaphor provides a visual image for other readers, yet leaves the interpretation to the reader:

> Science can be taught....as a lifeless collection of laws, facts, and relationships, or it can be revealed as the dynamic process.... Every year I try to move a little further.... along the path (of the dynamic process)....but I can only do this as my own understanding of the "dance" grows.

Next, Jay defines the dance by alluding to the way theory and method interact (*The dance,* Jay, 94-04-26).

> Theory dances around and through the experiment, and vice versa....The constraints of acting within the bounds of data and models actually requires a thinking and rethinking, which is joyful.

Finally, Andrew elaborates on the metaphor of the dance. He tells of an instance when he understood a particular physics concept in a wholly different way. He also suggests a paradox: models in physics represent the uncertainty in the world (*The dance/The joy,* Andrew, 94-04-27).

> I think the joy of discovery for me came when all of a sudden...I saw the motion of a turntable as just another perspective on the motion of the pendulum. After that, I looked for waves everywhere! And when modern physics and paradox seemed to enter the world again, I began to feel that now physics was beginning to reflect the uncertainty of real life....

These three initial messages provided a *leitmotif* for the rest of the conversation. In presenting her dissatisfaction with the sterile approach of the "scientific method," Colleen questions common perceptions about how science in practiced. In raising this challenge, she reflects on herself as both a learner and a teacher. By ending her message with the visual metaphor of the "dance" she creates ambiguity and suggests an image, which Jay then makes more explicit. Andrew builds on the metaphor and the definition by describing how he experienced the "dance" in coming to his own understanding about waves and particles.

The initial messages posed an interesting problem - pro forma science versus adventurous science - that would draw others into the conversation. By recounting relevant learning and teaching experiences, Colleen and Andrew gave a personal flavor to the message that welcomed teachers to consider how their own ideas about science had developed. Jay's definition of the "dance" provided a touchstone to which other teachers could react, just as Andrew had modeled in his response to Jay's message. These opening messages framed the conversation about theory and method; they also created a context for teachers with differing levels of knowledge and experience to enter the conversation. Instead of invoking

a complex scientific rationale, they shared their dilemmas and learning and teaching experiences, placing themselves wholly in the conversation.

Messages that Sustain Interest in the Conversation

Although the conversation was off to a good start, continuing it required messages that would explore how "real" scientists practice science. The conversation also needed some grounding in practice so that it was programmatically useful for teachers' practice. One way of documenting the influence of messages on a conversation is to analyze the messages to which participants frequently refer. DiMauro and Gal (1993) have found that pivotal messages in a conversation - messages that trigger rich response and further discussion - are ones that have a high number of referents in the discourse.

The participants in the *Against Method* conversation referred to two of David's messages more than any other messages in the conversation (see Table 1). *Re: The Dance* (David, 94-05-03), was referenced in seven subsequent messages and *Re: Against Method* (David, 94-05-16) was the stimulus for seven additional messages. In both messages, *Re: The Dance* and *Re: Against Method*, David pursues the discussion of the scientific process along philosophical grounds, citing authors who have written about these issues in light of the philosophy of science.

Table 1. Messages and Their Subsequent References in the Conversation

	Message Title	Indirect Reference	Direct Reference	Total
1.	What science leaves out *Colleen*	1	2	3
2.	The dance *Jay*	2	1	2
3.	The dance/The Joy *Andrew*	0	1	1
4.	The Dance/The Joy/The Story *Ted*	0	0	0
5.*	**Re: The dance** ***David***	**2**	**4**	**6**
6.	Against method *Colleen*	1	0	1
7.	Re: Against method *David*	0	0	0
8.	Method? *Andrew*	1	0	1
9.	Re: Against method			

	Colleen	1	0	1
10.	Re: Against method *Andrew*	1	0	1
11.*	**Re: Against method** ***David***	**3**	**3**	**6**
12.	Galileo, et al. *Colleen*	1	1	2
13.	Re: Galileo, et al. *David*	0	0	0
14.	Re: Galileo, et al. *Dick*	0	1	1
15.	Mucking around *Andrew*	2	1	3
16.	Re: Mucking around *David*	1	0	1
17.	Re: Mucking around *Jay*	1	0	1
18.	Muck II *Andrew*	0	0	0
19.	Re: Mucking around *Andrew*	2	0	2
20.	Re: The right way *Jay*	0	0	0
21.	Re: Muck II *David*	0	0	0

In David's message, *Re: Against Method,* he gave a brief synopsis of Paul Feyerabend's book, *Against Method*, in response to Colleen's and Andrew's request for more information. David does not, however, simply report the main findings of the text impartially. Rather, he raises the controversial issues that Feyerabend addresses in his text, and does so in a way that provokes responses by employing language to which others will inevitably react (*Re: Against Method,* David, 94-05-16). He begins the message by asserting that there is no such thing as one scientific method.

> I don't know whether I can do the book justice, but the basic idea is that there isn't any "scientific method," and we shouldn't expect there to be. If you really look at what scientists do, it isn't very methodical.

The argument David uses in the next part of this message shapes the discussion in new ways. By describing Galileo's methods (based on Feyerabend's analysis) as rhetoric, manipulation, and treachery, David suggests that Galileo's approach to scientific discovery was the antithesis of the scientific method. Galileo reported findings that his experimental data showed to be false.

> Feyerabend uses Galileo to talk about all of the rhetoric and manipulation, and trickery he did to get us to believe him, and it is a mistake to think he was impartially observing the world, making hypotheses and drawing conclusions. According to Feyerabend, much of what Galileo was claiming to be true was shown to be false by experimental results....In the end, it was very productive to Galileo to be so unmethodical in his work.

What seems to spark the next series of messages in this conversation is the suggestion that being unmethodical actually was a more productive stance for Galileo to take. He had a vision, believed he was right, and refused to discard his idea because there was not yet experimental data.

Andrew's response that immediately followed David's post references Goethe's works [3] and philosophy as a scientist who subscribes to the eighteenth century view of science and imagination espoused by such British contemporaries as Wordsworth.

> Lately I've been in this class that looks at the methods of Goethe as a scientist, and compares them with the methods of Newton. They are supposedly opposite archetypes, Newton being the classic reductionist on the shoulders of Galileo, while Goethe is the more "Holistic" of the scientists. Goethe had some interesting idea about the way that we look at the world, or discover things about it.... They explain phenomena, and are inherently simple. They also fly in the face of Newton and his intellectual descendants.
>
> Goethe mucked around an awful lot, allowed an idea to grow, often for years in his mind until it reached fruition. He eventually came to this picture of an "ur-plant", the archetypal plant from which all plants are derived. He saw it in his mind's eye, and it was as real as anything that he might dissect.

With this message, Andrew returns to the tone of the opening discussions about how to preserve the joy of discovery in scientific inquiry. He responds to David's often-referenced message by evoking the support of scholars. Each turn in the conversation enhances and deepens the discourse. By skillfully bubbling between the philosophical and the pragmatic world the teachers are able to ground their discussion without letting go of intellectual pursuits.

David's introduction of confounding elements in the discussion generated multiple responses as he raised a controversial issue using strong terms. This role of "devil's advocate" in intellectual discussions, both on and off-line, is often a catalyst for a conversation. In network conversations, however, this role takes on new importance and new risks. The asynchronicity of electronic discourse makes it easier for participants to "let" the conversation end. Strongly opinionated messages, however, sometimes stimulate new messages and, thus, the continuation of a dialogue. In fact, we have noted in our research that messages such as David's can bring active readers [4] into the conversation *(Jacobs and DiMauro, 1994)*. This seems to have been the case with the message that Dick posted shortly after David described Galileo's message (*Re: Galileo, et al.*, Dick , 94-05-21).

> Feynman, in a segment of the Nova "The Best Mind Since Einstein" had the best "scientific method" lecture I have ever seen. In it he says, the scientist makes a guess. Then uses the guess to make a prediction. Then does an experiment to check the prediction. If it checks out, OK; if it does not, the guess is WRONG. No matter how smart or famous the scientist, it is WRONG!

This was Dick's first message in the folder, suggesting it was his disagreement with David's

message that prompted him to respond.

Ideas that Get Ignored

The conversation's theme - what method leaves out - was examined from only one perspective - what method leaves out. The participants did not consider what method and data contribute to science's theories nor did they examine methods' values. Instead, when Dick and Jay posted messages from the perspective of *what method leaves in*, no one referred to their messages or addressed the issue.

Dick first raised the value that data play in theory building. In May, a month after the conversation had started, Jay responded to David's message about Galileo. In effect, Dick rebuts David's (and Feyerabend's) theory about the futility of data and method in great scientific discoveries (see Dick's message above).

Two weeks later Jay posted a message in support of Dick's although he does not refer to Dick's message. Instead, Jay refers to a message that Andrew had posted about the way that scientists "muck" around with ideas; that is, they explore theories not necessarily with some procedure in mind. In his message he described how "data rule" in his science class (*Re: The Right Way*, Jay, 94-06-01).

> Andrew, I struggle with this often. I try to model "doing physics" on the small scale. I am often working on some sort of problem which is driving me crazy. I build and calibrate wind tunnels, derive equations about daylight hours, and constantly draw my students into these mini excursions.
>
> This allows me to skirt around the "is Newton correct" issue. I enjoy physics, but many of the philosophical features of current models leave me estranged. :| [5]
>
> We do mostly macroscopic physics, much of it very empirical, so in my class, data rules!
>
> jay

Both Dick and Jay employed many of the same strategies that Andrew, Colleen, and David had used in posting their messages, and whose ideas were carried forth in the conversation. Dick invoked the authority of the Nobel physicist, Richard Feynman, known for his creative genius. Dick did not discount the creative process inherent in science; rather, he argued from the premise that data must eventually support one's guess or prediction. Without verifiable information, it is still a guess, not yet a theory.

Jay shared one of the strategies he uses as a teacher. By inviting students into a real science dilemma, he engages them in the working world of the scientist. Like Colleen's, Jay's message has an oblique quality that could invite discussion. For example, readers may be left wondering what he means by "...avoiding the 'is Newton correct,' issue." Does Jay believe that Newton's theories have been surpassed by twentieth century theories of physics? Does he think Newtonian physics offers students an important conceptual foundation, but discussions about Newton's "rightness" are beyond a high school student's understanding? Others might have asked him these questions. They also could have asked

Jay to talk more about the philosophical discussions of current theories and why they left him feeling estranged. No one-not even Andrew - to whom Jay had addressed this message, responded to *Re: The Right Answer*.

Dick and Jay voiced an opinion that was not supported by the other members in the conversation. Although both raised valuable points and employed many of the successful tactics for fostering conversation that others used, no one publicly responded to the other side of the data - theory issue by posting in the folder. There are many conceivable reasons why the other members of the discussion choose not to respond to dissenting ideas. Some members may have worked out their disagreements on private e-mail. For example, Andrew may have written Jay a private message that would not be seen by members of the community. Participants may not have been interested in pursuing the line of questioning that Dick and Jay raised. It is, of course, not possible to know why others did not respond to their messages simply by reading the discourse. We have found, however, that bypassing dissenting comments is a trend in the LabNet community's discourse.

Reflecting on and disagreeing about ideas, concepts, philosophies, and pedagogy is the hallmark of science. It is yet another aspect of theory building. When scientists publish their work, others attempt to replicate their findings or point to other research that supports or contradicts new findings. And, some debates last through several generations of scientists. We assert that teachers of science need professional forums that promote such lively debate about ideas.

Early in the conversation Colleen, Jay, and Andrew proposed that theory and data dance around each other, yet the participants studied only one of the partners - scientific methods are less important than theory in the discovery of new ideas. They did not consider the "dancers' choreography" in the conversation so they did not explore the intricacies of theory and data. Part of this may be that such a debate and disagreement is not sanctioned in the school culture. Forums for scholarly disagreements are not built into the typical professional life of teachers. Thus, intellectual debate, argument, and disagreement do not have a place in the teachers' professional work. When dissent does occur it often is centered on issues in which teachers stand behind organizing bodies such as unions.

Network-based discussions can offer opportunities for teachers to voice professional dissent, engaging in dialogues about classroom practice, educational reform issues, and subject specific issues. Yet, they most often do not. Instead, it has been our experience on the LabNet network that teachers frequently ignore controversial issues or react to them using private electronic mail *(DiMauro and Muscella; 1995)*.

We are now monitoring two LabNet conversations in which there is disagreement. One called, *Racism*, is a discussion about *The Bell Curve (Herrnstein and Murray, 1994)*. This has turned into a very strong debate about the contributions of genetics and the environment on human intelligence. We have observed that teachers are taking stands and disagreeing with one another. Similar debate and disagreement are also part of the current

Gender Issues folder. Although we are only beginning our analysis of these conversations, we speculate that the highly personal and political nature of both conversations prompts teachers to take a stand. We suspect that, for some teachers, these particular conversations are compelling in their own lives and the lives of their students. They already have strong opinions on these issues so when they see a position counter to the one they hold, they stake a claim on the opposition.

Placating and oblique group discourse are commonly found in close-knit communities both on and off electronic forums. "Flaming" is another manifestation of disagreement in the network. With "flaming," emotionally charged messages, often conveying anger, are posted. We argue that both passive and aggressive behaviors can be largely attributed to the diffused accountability of one's actions and words on a network. Furthermore, we argue that an eclectic community like LabNet benefits from neither the ignoring of controversy nor the inflamed messages. Rather, network communities seem to benefit most when there is a forum for informed dissent *(Little, 1993).*

DISCUSSION

More than three decades ago social psychologists studying patterns of communication found that proximity was one of the most important factors that contributed to social discourse and friendship *(Cofer and Apley, 1963).* This research was conducted well before electronic networks. Now it is possible to develop friendships - professional and social - and have conversations with people who live thousands of miles away. Through the use of electronic forums individuals can engage in thoughtful conversation with other professionals who have similar interests and expertise. These are often teachers who live hundreds of miles away, making professional face-to-face collaborations nearly impossible. Physical proximity is no longer the primary vehicle for social interaction, provided one has a computer, modem, and an e-mail account.

For the teaching profession electronic discourse has important implications for professional development. In the case of the conversation, *Against Method,* science teachers in Minnesota, California, and Massachusetts engaged in an eight-week conversation in which they delved into the nature of science, exploring how scientists develop and test their theories. It is hard to imagine this conversation as any other than an electronic one. Even on the most basic level, unless specific required readings were required by a school, and that school employed many science teachers - which would be unusual - it would be rare to find eight other science teachers who have read the same texts and wanted to talk about their interpretations. In fact, the culture of schools mitigates against teachers in the same building or district having this kind of conversation during the day-to-day commerce of their work. We know that teachers are generally isolated and it is the rare faculty that engages in intellectual conversation about pedagogy, let alone science *(Little, 1993; McLaughlin, 1993).*

Although electronic networks have the capacity to offer professional development

opportunities usually unavailable to teachers in their school community, electronic networks may contribute to isolating teachers from their school colleagues. Just as the majority of LabNet teachers access the network from their home, network services are most frequently paid for by the teachers themselves *(Jacobs and DiMauro, 1994)*. Due to financial and time constraints, teacher-based networks are not commonplace in schools. As technology grows increasingly more accessible and less costly there is need to explore ways to bridge on-line professional learning with teachers' school community.

What is now needed is a closer examination of what supports conversation about science and pedagogy on electronic networks. By designing learning environments that encourage teachers to participate in electronic communities, we will begin to identify those factors that foster reflective conversations. We next need to enable teachers who participate in electronic communities to bring new ideas and knowledge back to their school colleagues. This will help us uncover ways to foster professional conversations among teachers who share conversations around the coffee pot and in the teachers' lounge of their schools. We assert that many changes need to be made in the present school-day structure to support a climate for the professional discourse now available primarily on networks, critical for sustained reform in teaching science.

There were 25 messages in the conversation, *Against Method*. Some messages, like Colleen's Jay's, and Andrew's provided the foundation for the subsequent discourse. Others, like David's, continued to stimulate the participants to think more deeply about the conversation. What causes any one message to stimulate much of a network conversation? How can informed dissent be facilitated in both on-line discussions as well as in teachers school community? And, perhaps more important, what precipitates and sustains such a conversation among teachers?

Addressing these questions has important implications not only for electronic networks, but for designing effective vehicles for teachers' professional development - "on- and off-line." It is unlikely that electronic networks for teachers alone, no matter how rich and stimulating, can effect the reforms currently called for in science education. As the educational community learns more about telecommunications for teacher development, research and implementation needs to distill properties of substantive dialogue and the path that networks take in teachers' professional development.

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Dr. Deborah Muscella has extensive experience as a staff developer and researcher. She has studied the process of school change, looking at the role teachers and administrators play in supporting changes in teaching practice. She has conducted collaborative research with teachers to examine how students develop their understanding of statistics and data analysis. Most recently, Dr. Muscella has directed the Infusing Statistics project, a multi-state teacher development project funded through the US Department of Education.

Vanessa DiMauro's background includes six years of experience in implementation, research and evaluation of computers and telecommunication in education. Her studies have focused on analyzing the impact of technology on educational learning environments. Formerly she directed the research team at University of Mass, Donahue Institute for Governmental Studies, assessing state vocational/technical education systems. She currently does research for the TERC's LabNet project.

Footnotes

1 - An earlier version of this paper is forthcoming in the SITE Conference Proceedings, San Antonio, TX. March, 1995.

2 - Special thanks to the LabNet staff and teachers for reviewing drafts of this paper.

3 - Goethe is often better known for his works as a writer than a scientist. However, there are traces of both domains overlapping through out his study. For example, GÏtheÕs Faust is an epic drama about the pursuit of knowledge that raises, among other things, the question of how to reconcile the powers of science and imagination.

4 - Jacobs and DiMauro (1994) have documented that there are frequently several active

readers of a network conversation - those who are reading the conversation without actually posting.

5 - Jay uses an emoticon (a textual way to convey an emotion), : | to show his lack of enthusiasm.

LabNet Research Page

LabNet home page

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